MUNESCO

Forum: SF1 - Social and Human Sciences
Issue: Improving the safety of or finding ethical alternatives to genetic modification and experimentation
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Introduction

Genetic modification is the usage of biotechnology to manipulate an organism's genes and transfer genes from one species to another. The genetic code is universal, which allows the amino acid sequence remain unchanged when genes are transferred. Genetic modification is most commonly used to implement new characteristics in organisms in order to improve their quality. Genetic engineering is frequently used in agriculture and medicine and however may also be used on animals for scientific means; such as hormone production, organ repair, and experimentative research.

The reasons why genetic modification in animals is not so frequent relate to the safety and ethics involved with genetic engineering. Genetic engineering is a completely artificial process and therefore the outcome of the process cannot be predicted since the products do not spontaneously occur in nature. In correlation, the short and long term effects of genetically modified organisms (GMOs) on human health, agriculture and the environment were completely unforeseeable. Besides the obscure safety of this process, genetic modification is also considered unethical due to the lack of information on the topic and the unnaturality of the procedure. Genetic engineering and research on the subject are thus highly limited.

However, even though many scientists have been criticized in extreme cases of genetic modification, as a result of lack of laws and regulations the unethical processes of genetic engineering still prevail.

Definition of Key Terms

Genetic modification: The artificial altering of an organism's DNA or other nucleic acids using biotechnology.
Biotechnology: Technological applications that use biological systems to produce or modify products.
Ethics: A set of moral obligations that, in this case, limit scientific applications on contentious notions.
Deoxyribonucleic acid (DNA): A molecule composed of nucleotides which contain genetic codes for the functions of life.
Nucleotides: Monomers composed of nucleic base, sugar and phosphate, that form DNA and RNA.
Gene: The sequence of nucleotides that code for a specific function.
Phenotype: An organism's characteristics, including structure and function.

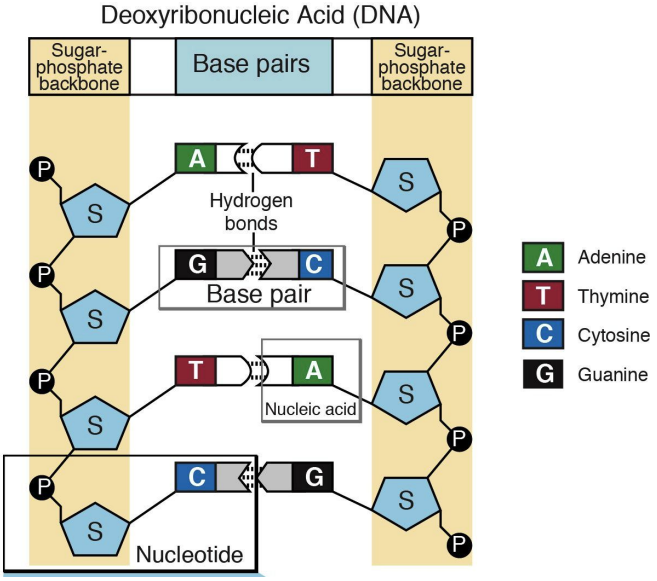
Enzymes: Specific proteins that can accelerate chemical reactions.
Restriction enzyme (endonuclease): Enzymes used in genetic modification, which can cut the DNA.

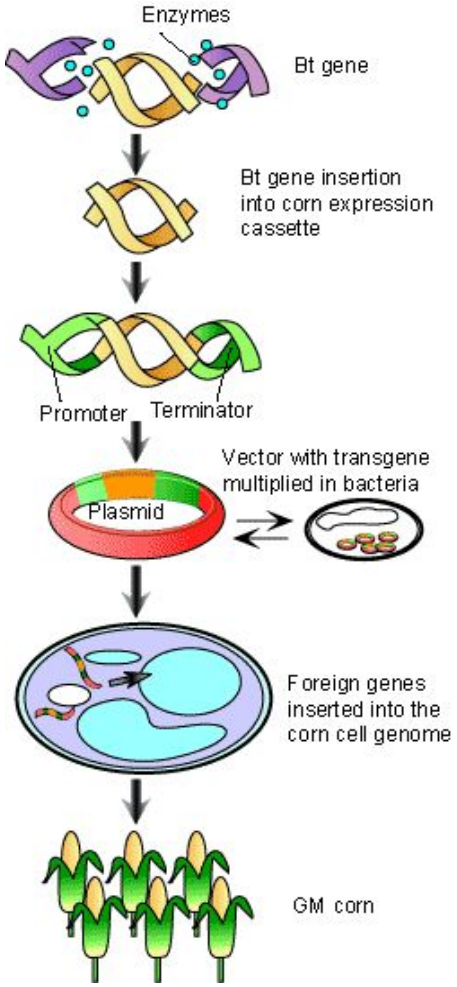
Background Information

Genetic Modification:

Genetic modification (GM) is a procedure in which the deoxyribonucleic acid (DNA) of an organism is altered. DNA consists of nucleotides which are made up from nitrogenous bases, sugars and phosphates, and contain genetic information.

For research purposes, DNA can be amplified through polymerase chain reaction (PCR). The abundance of DNA can be cut into fragments by restriction endonuclease (an enzyme) to be used in DNA profiling which compares DNA. This method is used in paternity tests.





The modification of DNA is a similar process: the restriction endonuclease is used to cut a piece of DNA, this segment is used to replace another segment in the DNA of another organism. This can be seen in the production of insulin where complementary DNA (cDNA) produced from human pancreatic cells are fused with plasmid of bacteria using DNA ligase (a binding enzyme). The modified bacteria is fermented and produces insulin. The same procedure goes for GM in agriculture.

Safety & Ethics:

The most concerning aspect of genetic modification is that since it is a fairly new procedure, there isn't an adequate amount of experiments and sufficient time for such studies that explore the long term effects of genetic modification on animals, plants and the environment. An example could be the experiment planned in the 1970's by Paul Berg which aimed to implement a virus from monkeys to the bacterium *Escherichia coli*, which is found in humans. This study gained vast criticism since the virus was known to cause cancer in mice, and therefore the genetically modified *E. coli* could theoretically cause cancer in humans. Since there simply wasn't enough information on the possible outcomes, the experiment was never executed.

The uncertain truth about the safety of GMOs leads to the ethical inconsideration of the process. Since there is no a priori knowledge, as the products are not self-evident in nature, it is difficult decide on how to limit the research.

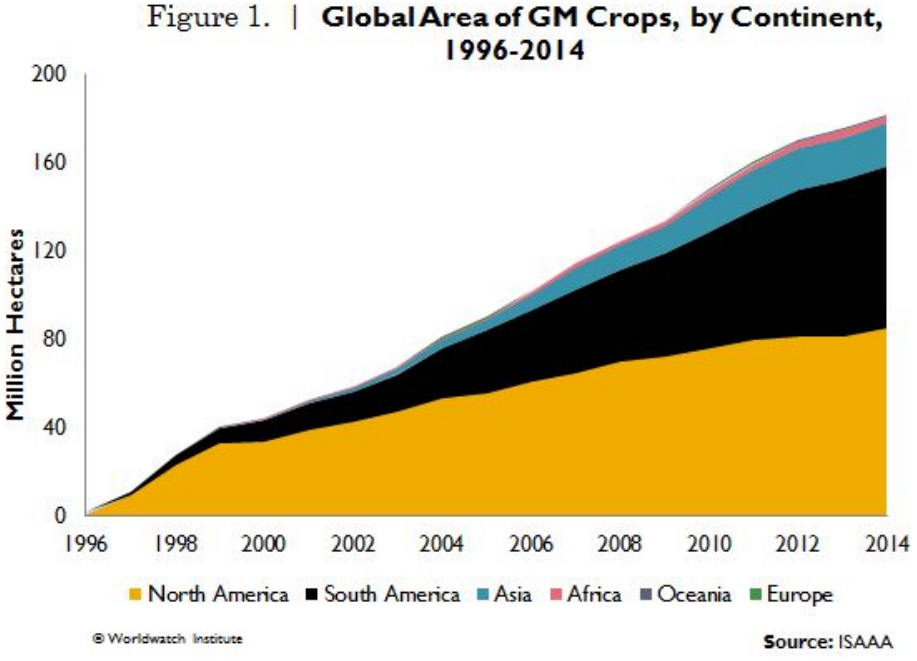
Another issue is consent. When genetically modified crops are served to the public unlabeled, society is being mislead and prone to the unknown effects unnotified. When human embryos are being modified, they cannot get the direct consent of the child, even if they have consent from the parents. The knowledge of being genetically modified might result in psychological problems in the organism in the future. In addition to this, asking for consent without knowing the exact and possible outcomes defies morals and is completely unethical on its own.

Future Problems:

One of the most concerning future complications could be how genetically modified embryos can show psychological signs of distress, due to the lack of information on the results of genetic modification of humans and dissent. Genetically modified organisms can lead to unknown or new diseases, similar to how the modification of *E. coli* might lead to cancer. Genetic modification can be considered as a type of mutation, which usually results in negative outcomes.

Even if a human is not directly modified, the products that they consume probably are. When GMO products are not labelled, this might lead to undiscovered diseases in humans, or spreading of diseases which might have been caused by carelessness during the process of modification.

As it can be seen on the graph, genetically modified crops have augmented substantially over the past 20 years.



Although there is no evidence to support the dangers of genetic modification, the problem is the lack of evidence on the topic in its entirety. It is not known if genetic modification can lead to devastating

outcomes, or to very beneficial results. Until further research discovers the true aftermath of genetic modification, the system will remain concerning, unsafe and unethical.

Timeline of Major Events

1804	The cell nucleus was described by Franz Bauer.
1831	The nucleus in orchids was discovered and described by Robert Brown.
1865	Gregor Mendel established the science of genetics, extracting knowledge from the experiments he carried out on his garden plants.
1866	Ernst Haeckel discovered the genetic material in the nucleus.
1890	A rabbit was created through in-vitro fertilization (IVF).
1944	The role of DNA in genetics was discovered by Oswald Avery.
1951	Rosalind Franklin discovered the double helix structure of DNA, however James Watson and Francis Crick were credited as the discoverers.
1968	Stewart Linn and Werner Arber discovered the restriction enzyme.
1973	Herbert Boyer and Stanley Cohen developed the first genetically modified organism, a type of bacteria.
1974	The first genetically modified animal, a mouse, was produced by Rudolf Jaenisch.
1976	Prenatal genetic diagnostic tests were discovered.

July 25th, 1978	Louise Brown, the first human created through in-vitro fertilization, was born.
1978	Studies for the production of the first human insulin was commenced.
1982	The first genetically engineered medicine, insulin, was produced by the Eli Lilly Corporation and released to the public.
1983	The first genetically modified plant was created.
1986	The first embryo from sheep was cloned.
1990	The Human Genome Project (HGP) was launched to determine the sequence of bases that make up human DNA.
1991	Gene therapy, aiming to treat and prevent genetic diseases, was tested on humans for the first time.
July 5th, 1996	Dolly, a sheep that is the first mammal cloned from an adult somatic cell, was born.
2001	The human genome sequence was published by the HGP.
November 15th, 2018	He Jiankui claims to have produced the first genetically modified humans. He was ethically criticized by scientists around the world and has reportedly gone missing after being dismissed from the Southern University of Science and Technology in Shenzhen.

Major Countries and Organizations Involved

World Health Organization (WHO):

The World Health Organization, founded in 1948, is a United Nations agency that focuses on international public health. The organization has been affiliated with genetic modification and

genetically modified organisms since the invention of GM, and has remained active in matters concerning GM since 1991.

Non-GMO Organization:

The Non-GMO Organization is a non-profit organization which was founded in 2007 in North America. The purpose of this organization is to prevent the marketing of GMOs in agriculture. This organization has gained a faithful audience concerned with their health, which lead many corporations to use non-GMO products for marketing purposes.

Food and Agriculture Organization (FAO):

The Food and Agriculture Organization is another agency of the United Nations, fixated on issues related with food. This organization has been one of the first to be concerned with genetic modification and the undiscovered risks that might arise from the process, along with WHO.

European Union (EU):

The European Union is a formation of 28 European countries, concentrated on almost all international matters. The EU has strict regulations on agriculture and genetic modification, one of the most dominant being the requirement of labelling of GM products.

European Food Safety Authority (EFSA):

The European Food Safety Authority is an EU agency, founded in 2002. The organization focuses on the safety of foods and threats to the food chain, genetic modification being one. EFSA is responsible of evaluating genetically modified food products, on their health risks, before they are released to the market.

United States of America:

The United States of America remains one of the leading countries in terms of all things, including: agriculture, genetic modification, and lack of regulations associated with GM. The limited legislations are due to the fact that the U.S. mainly focuses on the products received instead of the process of production. Although these principles might be considered unethical, it is not surprising, seeing as the United States is the largest developer of genetically engineered goods.

Previous Attempts to Solve the Issue

"Strategies for assessing the safety of foods produced by biotechnology", Report of a Joint FAO/WHO Consultation. (World Health Organization, Geneva, 1991)

This is a report on the safety of technologically produced nutrients, elaborated on when the Food and Agriculture Organization congregated with the World Health Organization in Geneva in 1991.

"The safety evaluation of foods derived by modern technology – concepts and principles", Report of the agreement of OECD's Group of National Experts on Safety in Biotechnology. (Bergen, Norway, 1993)

OECD's Group of National Experts on Safety in Biotechnology, evaluates biotechnology in general. This report is of their meeting in Bergen, Norway in 1992 where they accorded on ways of assessing the safety of genetically modified food.

The Cartagena Protocol on Biosafety (Montreal, Quebec, Canada, 2000)

This protocol, followed by 171 parties, aims to protect life on Earth from the unknown risks of genetic modification. It was drafted on the 29th of January, 2000, signed on the 15th of May and has been effective since the 11th of September of 2003

Directive (EU) 2015/412 of the European Parliament and of the Council (2015)

This is a directive on the topic of the Member States restricting or prohibiting the cultivation of genetically modified organisms (GMOs) in their territory.

Commission Directive (EU) 2018/350 (Brussels, 2018)

This directive of the European Union is focused on assessing the environmental risks of genetically modified organisms.

Possible Solutions

- Recommending governments to impose laws and regulations to illegalize not labeled GMOs.
- Promoting studies on the long term effects of genetically modified organisms.
- Opening research facilities on genetics and genetic engineering, to explore the aftermath of genetic modification.

- Regulating genetic modification laboratories and research centers.
- Encouraging the use of organic production to farmers.
- Informing the general public of the unknown effects of genetic modification and attempting to raise awareness on the health risks it might be correlated with.

Useful Links For Further Research

- https://ec.europa.eu/food/plant/gmo/legislation_en
- https://www.who.int/foodsafety/areas_work/food-technology/faq-genetically-modified-food/en/
- http://in.bgu.ac.il/en/Global/Documents/General/ethicseng.pdf
- http://www.actionbioscience.org/biotechnology/glenn.html
- https://www.statista.com/topics/2062/genetically-modified-crops/
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